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## General aspects regarding the organic cultivation of wax gourd in Romania

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### Abstract

The climatic changes from Romania in the last decades, affected the productivity of local plants especially in south of the country where there are many droughty areas. Our objective was to identify new opportunities for protecting the environment in these areas by emphasizing the potential of cultivation of more resistant plants. With these aim in mind we conducted in 2013 two experiments of growing wax gourd, a plant specific to lowland tropical land. Our experiments (E3 and E4) came to complete the researches regarding this plant performed in 1960 (E1 and E2). We analyse these experiments in a comparative manner to present in this way the behaviour of plant in four types of cultivation: greenhouse; hotbed; open field – direct sowing; open field – planting seedlings. The results revealed a high yields potential (until 80 tons per hectare) and an improvement in soil composition which was enriched with nutritive substances, especially potassium and phosphorus. In this way, the wax gourd can be described like a very good plant for environment protection and also a plant with a high productivity. The results obtained permitted us to recommend the introduction of this plant in Romanian flora in areas with low alkaline reaction (pH over 7), high temperatures during summer (over 30°C) and low level of precipitations (under 225 l/m<sup>2</sup> in June-September period).

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### 1. Introduction

Wax gourd (*Benincasa Hispida*) is a tropical plant known for its role in improving human health (Trankell, 1995) and has been planted in Asia from ancient times. Archaeological evidences place this plant in ancient China (Marr and Xia, 2001), in Thailand (9000 years ago) (Pyramarn, 1989), in New Guinea (2500 years ago) and in Japan since 300 BC (Matthews, 2003).

At present the plant is widespread on all continents under different names like: ash gourd, winter melon, fuzzy melon (english); tungkua (chinese); tougan (japanese); abobora de agua (portuguese); bi dao (vietnamese); kushmanda or kusmandah (sanskrit); Chalkumra (bengalese); Kushmanda or Petha (hindu) etc.

Wax gourd is an annual plant, with climbing vines and a long stem of 2-5 m in open field or 8-12 m in greenhouse environment. From technological point of view the plant can be grown on well drained sandy soil or clay loam, with a pH of 5.5-6.8. In the cultivation area medium temperature needs to be between 25-30 °C, over 10 °C during the first steps of growth period and without long periods of high humidity or shadow (Morton, 1971). Regarding the fertilizing process, in organic agriculture can be applied 20-25 tons of manure (before planting or during the growing period) or phosphorus and potassium fertilizers and in conventional agriculture ammonium sulfate (up to 150 kg /ha) can be applied during the growth period (Srivastava and Sachan, 1969).

In Romania, in 1960 was conducted an experiment regarding the cultivation of wax gourd by the researchers from Agronomic Institute “Nicolae Balcescu” (Chirilă et al., 1961). Since the ‘60s the experiments were not reproduced even the plant showed a good adaptation to the pedological and climatic conditions from our country.

Our paper aims to present a comparison of the experiment organized 50 years ago, with the main results of two experiments performed during 2013 periods regarding the cultivation of wax gourd in our country, one with direct sowing in open field and one by planting seedlings. Our research completes the mentioned experiment and point out the opportunity of introduction of this plant in Romanian flora and other European areas with similar pedological and climatic characteristics.

## 2. Materials and methods

The experiments that we want to present had the purpose to observe the technological and biological comportment of wax gourd under the pedological and climatic conditions from Romania. These experiments performed in south of Romania can be differentiating such as:

- *E1 – greenhouse growing conditions;*
- *E2 – cultivation of seedlings in hotbed conditions;*
- *E3 – cultivation directly in field;*
- *E4 - cultivation of seedlings in field.*

The experiments **E1** and **E2** were made in 1960 at Băneasa Farm of Agronomic Institute “Nicolae Bălcescu” Bucharest. Experiment **E1** consisted of sowing 3 plants from an oblong variety of wax gourd and growing them in a greenhouse and experiment **E2** consisted in obtaining the seedlings from 3 plants from an oblong variety of wax gourd and the plantation in a hotbed environment. For these experiments we don’t have any information regarding soil parameters.

The experiments **E3** and **E4** were made in 2013 on a 150 m<sup>2</sup> field from Călărași county (Fundulea village) (**E3**) and on a 30 m<sup>2</sup> field from Giurgiu county (Herasti village) (**E4**), on organic experimental fields. Experiment **E3** consisted of sowing 50 nests with biological material *Benincasa Hispida* "Hybrid Wonder Wax" on a field with the following characteristics:

- soil medium;
- sandy clay texture;
- water retention proprieties;
- low porosity and permeability (fine sand – 28,1 %; dust – 33.1 %; clay – 38.8%);
- pH of 6.3 – low acid reaction;
- hummus of 3.2%;
- organic compound - C organic < 2%;
- nutrients – medium input of Nt (0,180 %), low input of phosphorus P (28 mg/kg) and potassium K (108 mg/kg).

Experiment **E4** had two steps: growing seedlings phase in greenhouse and planting them in the open field. The main characteristics of experiment field are:

- soil medium;
- sandy loam texture;

- high water retention proprieties;
- very low porosity and permeability (fine sand – 53,0 %; dust – 24.3 %; clay – 18.5%); pH of 7.21 – low alkaline reaction;
- organic compound - C organic < 2%;
- nutrients – medium input of Nt (0,164 %), normal input of phosphorus P (47.6 mg/kg) and potassium K (276 mg/kg).

From a methodological point of view the experiments are comparable due to the fact that the areas have similar landscape characteristics and almost similar pedological and climatic conditions. Also the researchers didn't intervene with fertilizers or irrigation (except experiment **E1**), maintaining during experiments an organic environment. The differences however between experiments are made by the fact that during 1960-2013 the temperatures increased and the plants from experiments **E3** and **E4** were benefiting by a warmer weather during vegetation periods. We point out these differences between experiments based on Weather Spark Beta Data for year 1960 and our own measurements made in 2013.

In case of experiment **E1** the temperature from greenhouse was maintained around 35°C, but the temperature from hotbed area (Experiment **E2**) was influenced by high variations and until august by a large number of days with temperatures close to 20°C. During summer 1960 (vegetation period) the temperature exceeded 30°C only one day out of ten, the precipitations were higher in May and in the second half of August was registered a severe drought. In case of experiments **E3** and **E4** the temperature had an increasing trend being over 25°C starting with June. Our measurements performed during the experiments revealed the following climatic details (Fundulea Meteo Station data):

- Experiment **E3** – 81 days with 25-30°C (55.9%) and 35 days with over 30°C (24.1%); the precipitations: 11.4 l/m<sup>2</sup> during germination; 490 l/m<sup>2</sup> during growth and 60.6 l/m<sup>2</sup> during the developments of fruits;
- Experiment **E4** (a total of 95 days starting from plantation in open field on 8 of June) – 46 days with 25-30°C (48.4%) and 38 days with over 30°C (40.0%); the precipitations: 161.8/m<sup>2</sup> during growth and 64.8 l/m<sup>2</sup> during the developments of fruits.

Despite these differences we consider that each experiment can demonstrate the growth potential of wax gourd in Romania and the potential of cultivating this plant, especially in plain areas with high temperatures from our country.

### 3. Results and discussions

The experiments **E1-E4** were periodically monitored to identify developments of plant in the field and the vegetation period. For all experiments we present further the main observations and results.

Experiment **E1**:

- the sowing was made on 25 of March and the plants were moved in pots after approx. 26 days;
- on 12 of May seedlings were planted in greenhouse at a size of approx. 9-35 cm. tall, when they develop floral cufflinks and tendrils; maintenance works: irrigation, hilling, hoeing;
- the temperature in greenhouse was maintained around 30°C and in June at 35°C;
- the artificial pollination was done approx. 1-2 days before the opening of flowers;
- **Vegetation period** – 65 days from sowing until the first female flower; **196 days** total vegetation period; the harvest was done on 6<sup>th</sup> of October;

Experiment **E2**:

- the sowing was made also on 25 of March and the plants were moved in pots after approx. 26 days;
- on 19 of May seedlings were planted in hotbed at a size of approx. 9-35 cm. tall, when they develop floral cufflinks and tendrils;
- maintenance works: irrigation, hilling, hoeing;

- the pollination was done by insects;
- the temperature from end of May was under 20°C and affected the growth of the plants; when the fruits reach 2-3 kg they were placed on supports;
- **Vegetation period –167 days** total vegetation period (69 days from sowing until the first female flower); the harvest was done on 7 of September;

#### Experiment **E3**:

- the sowing was made on 7 of May at a depth of 4.5 cm (around 5 seeds per nest) and the distance between nests was of 1-1,5 m;
- **Vegetation period – 12 days** germination period (18 of May); 63 days until the first flower (20 of July); 38 days until the first fruit (27 of August); 32 days until harvest (28 of September) (a total of **145 days** of vegetation);

#### Experiment **E4**:

- had two steps - growing seedlings phase in greenhouse and planting them in the open field;
- the seedling was obtained by sowing 28 seeds in alveoli on 14<sup>th</sup> of May;
- the first germination was observed at the end of May and we moved the plants in pots on 8<sup>th</sup> of June until the plants reached almost 20 cm high;
- the plantation of seedlings took place on 23 of June;
- **Vegetation period –135 days** from which 40 days in greenhouse and 95 days in open field (31 days until the first flower- 23 of July; 28 days until the first fruit- 20 of August; 36 days until harvest- 25 of September).

In **E1** and **E2** the cultivation conditions were controlled by researchers. They intervened in flowers pollination due to the closed environment of growth even in hotbed environment. Also, the vegetation period in **E1** was with over 17% longer than in hotbed environment (**E2**). In greenhouse (**E1**), without any interventions (fertilizers), were obtained 11 fruits and their weight demonstrate a high potential of plant growth in this controlled environment (Table 1).

Table. The main results of experiments E1-E4

Specifications	1960		2013	
	E1	E2	E3	E4
Number of plants (reaching full growth)	3	3	115	28
Vegetation period	196	167	145	135
Number of days from sowing until first flower	65	69	75	71
Maximum stem length at harvest (m)	12	3	6.7	6.4
Number of fruits	11	5	73	84
Total weight - kg	49.6	17.98	155.76	259.36
Average weight of a fruit - kg	4.509	3.596	2.134	3.088
Maximum weight of a fruit - kg	7.850	6.510	5.05	11.575
Total sugar (g/100g)/fruit	1.84	1.28	1.93	1.86

Source: Own calculation

The low temperature from end of May affected the growth of the plant and the emergence of flowers in case of experiment **E2**. Only one plant had fruits, but the results obtained, respectively 3 fruits and a total of 17.98 kg permitted to reveal a high potential of field cultivation but in these conditions the results of **E2** were not concluding.

In **E3**, only 37 of 50 nest presented full growth plants (115), and only 69.7% of these had mature or immature fruits at harvest time (80 plants). The experiment with direct sowing in open field didn't confirm the conclusion of researchers from the '60s. The medium production per plant and the average weight were lower than estimated in **E2** and the maximum weight reached only 5.05 kg. However, the experiment allowed us to estimate a production of at least 8 tons per hectare.

Experiment **E4** presented better results. By planting seedlings in June, all the plants survived and the production was very high compared with **E3**. The vegetation period was the lowest, the average weight was 3.088 kg and the

maximum weight fruit reached 11.575 kg. If we consider the hypothesis that all the plants can survive, the experiment permitted us to estimate a production of over 80 tons per hectare. In the case of experiments **E3** and **E4** the plant was not affected by diseases specific to other cucurbitaceous plants from our country (cucumber, pumpkin, etc.), was not affected by insects, but suffered attacks from wild rabbits.

If we compare all the experiments we want to point out that regarding the quality of production the sugar extracts from obtained fruits have comparable values. Also, the comparison of results with the soil composition revealed that the plant its comporting much better on low alkaline soils (pH of 7.21 in case of **E4**) than on slightly acid soil (pH of 6.37 in case of **E3**). To observe the benefits for environment we performed an analysis of soil sample for experiments **E3** and **E4**, collected before and after cultivation of BHS (Table 2).

Table 2. Variance of soil nutrients (after and before cultivation) for experiments E3 and E4

Parameter	MU	E3	E4
pH		-0.07	+0.11
N	%	-0.005	+0.036
P	mg/kg	+30	+93
K	mg/kg	+192	+84
Organic composition	%	+0.67	+0.14

Source: Own calculation.

These analyses revealed that the plant improved the intake of nutrients in the soil especially potassium and phosphorus, and that the variations of pH, nitrogen and organic composition are very low.

#### 4. Conclusions

Wax gourd proves a high yield potential in a greenhouse environment, but especially in open field. Our observations permitted us to recommend the sowing in pots during May, the planting of seedling in June and the harvesting at the end of September until the temperature drop under 10<sup>0C</sup> during nights or until the first frost.

From a technological point of view, the plant performed better on alkaline soil, with a pH over 7.2 and normal values for nutrients, from areas with high temperatures and low and medium level of precipitations. By respecting these conditions the vegetation period is the lowest, the yield can reach until 80 tons per hectare and the average weight of a fruit can be around 3 kg.

In conclusion, the wax gourd grows very well in an organic environment, proving resistance to drought periods and showing a real contribution to improving soil nutritive compound.

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